NEOSHO RIVER BASIN TOTAL MAXIMUM DAILY LOAD

Water Body: John Redmond Lake
Water Quality Impairment: Siltation

Subbasin: Neosho Headwaters

Counties: Butler, Chase, Coffey, Greenwood, Harvey, Lyon, Marion, McPherson, Morris, and Wabaunsee

HUC 11 (HUC 14)**:** **11070201010** (010, 020, 030, 040, 050, 060)
11070201020 (010, 020, 030, 040, 050, 060, 070, 080, 090)
11070201030 (010, 020, 030, 040, 050)
11070201040 (010, 020, 030, 040, 050, 060, 070)

11070202010 (010, 020, 030, 040, 050, 060, 070, 080)
11070202020 (010, 020, 030, 040, 050)
11070202030 (010, 020, 030)
11070202040 (010, 020, 030, 040, 050)

11070203010 (010, 020, 030, 040)
11070203020 (010, 020, 030, 040, 050)
11070203030 (010, 020, 030, 040, 050)
11070203040 (010, 020, 030, 040, 050, 060)

Ecoregions: Flint Hills (28)
Central Irregular Plains/Osage Cuestas (40b)
Central Great Plains/Smoky Hills (27a)

Drainage Area: Approximately 3,000 square miles.

Conservation Pool: Area = 7,643 acres
Watershed Area: Lake Surface Area = 251:1
Maximum Depth = 4.0 meters (13 feet)
Mean Depth = 1.5 meters (4.9 feet)
Retention Time = 0.04 years (0.5 months)

Designated Uses: Primary and Secondary Contact Recreation; Expected Aquatic Life Support; Industrial Water Supply Use; Food Procurement

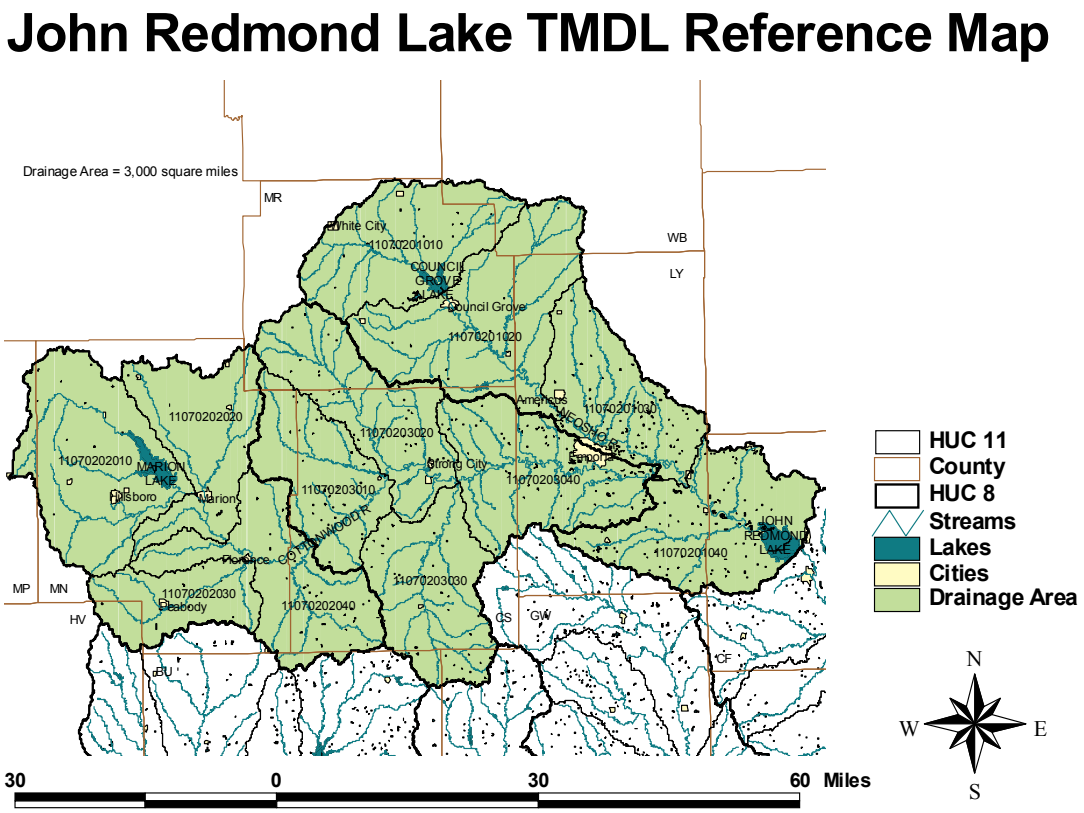
Authority: Federal (U.S. Army Corps of Engineers), State (Kansas Water Office)

1998 303d Listing: Table 4 - Water Quality Limited Lakes

Impaired Use: Expected Aquatic Life Support and Primary and Secondary Contact Recreation

Water Quality Standard: Suspended solids - Narrative: Suspended solids added to surface waters by artificial sources shall not interfere with the behavior, reproduction, physical habitat or other factor related to the survival and propagation of aquatic or semi-aquatic or terrestrial wildlife. (KAR 28-16-28e(c)(2)(D)).

Figure 1



2. CURRENT WATER QUALITY CONDITION AND DESIRED ENDPOINT

Level of Eutrophication: Argillotrophic, Trophic State Index = 48.98

Monitoring Sites: Station 026001 in John Redmond Lake (Figure 1).

Period of Record Used: Five surveys during 1987 - 1999

Kansas Biological Survey (1999 - 2000)

Current Condition: Surface water in John Redmond Lake has high turbidity, dominated by inorganic materials because the lake receives a steady inflow of silt. The lake is light limited (Appendix B). Based on samples taken by KDHE, the average transparency (Secchi Disc depth) is 23 cm (Appendix A), the average turbidity is 50.4 formazin turbidity units, and the average total suspended solid concentration is 46 mg/L. See the table below. Lakes are considered to have a siltation problem if they meet the following criteria: chronically turbid, trophic state index plots indicate light limitation, average chlorophyll a concentrations less than 7.2 ppb, and Secchi Disc Depth less than 0.5 meters. John Redmond Lake is deemed to be Argillotrophic, as its average chlorophyll a concentration is 6.53 ppb (TSI = 48.98), while its average total phosphorus concentration is 175 ppb.

Average Concentrations of Samples Taken by the KDHE Lake Monitoring Program

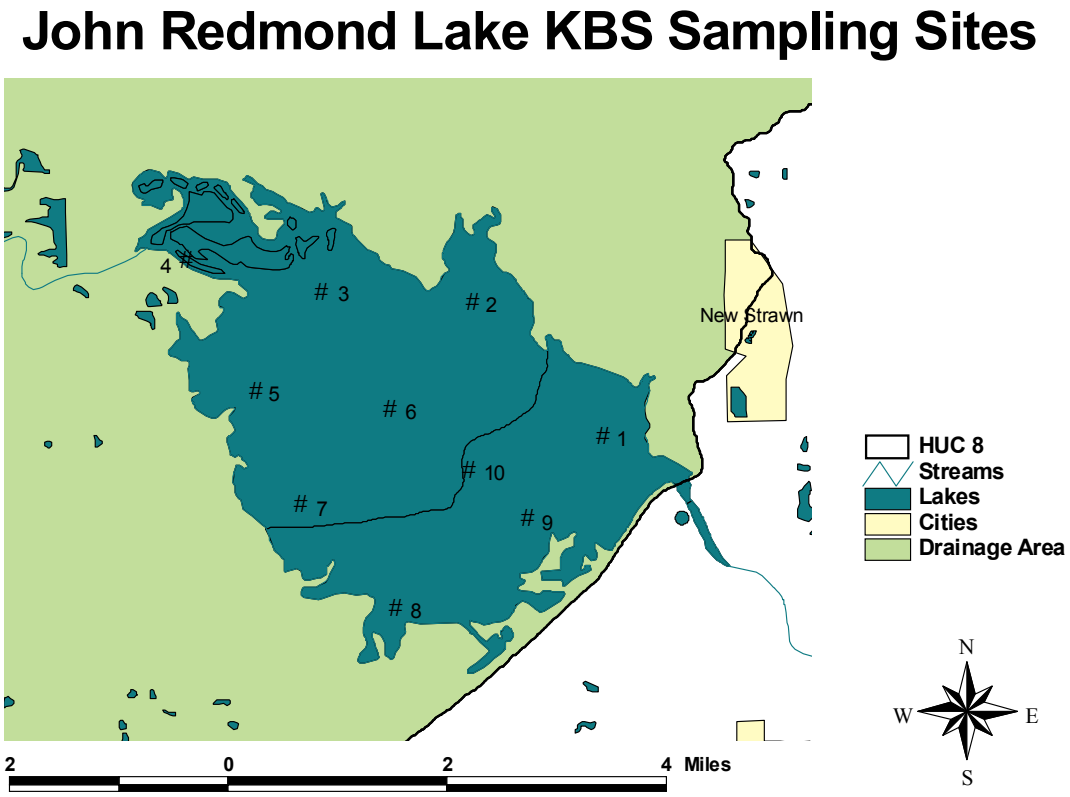
DATE	Average Total Suspended Solids (mg/L)	Average Turbidity (formazin turbidity units)	Secchi Depth (m)	Lake Elevation
9/1/87	73			
6/20/90	52	56.5	0.20	
6/14/93	12	13.8	0.40	
6/11/96	48	88.3	0.10	1040.41
7/13/99	39	43.0	0.23	1038.53

From June of 1999 to November of 2000, the Kansas Biological Survey collected data at ten stations (Figure 2) in John Redmond Lake. A summary of those results is included in the below table.

Average Concentrations of Samples Taken by the Kansas Biological Survey

Location	Average Total Suspended Solids (mg/L)	Average Turbidity (formazin turbidity units)	Secchi Depth (m)
Station 1 - Lacustrine	**497.4**	**144.1**	**0.19**
Station 2 - Riverine	**114.9**	**190.4**	**0.16**
Station 3 - Transitional	**204.9**	**191.6**	**0.16**
Station 4 - Riverine	**100.8**	**179.0**	**0.17**
Station 5 - Transitional	**81.3**	**169.5**	**0.21**
Station 6 - Transitional	**297.2**	**135.4**	**0.21**
Station 7 - Transitional	**551.8**	**145.6**	**0.21**
Station 8 - Transitional	**1107.9**	**128.5**	**0.21**
Station 9 - Lacustrine	**198.9**	**145.6**	**0.20**
Station 10 - Lacustrine	**181.9**	**133.9**	**0.21**

Figure 2



Loads were calculated for the Neosho River and Cottonwood River subwatersheds. From this analysis, it is evident that the Cottonwood subwatershed is making the greatest contribution to the sediment load. This conclusion is consistent with the land use assessment, because the Cottonwood River subwatershed has a larger drainage area than the Neosho River subwatershed.

Average Concentrations and Load at Stream Monitoring Stations

KDHE Station (USGS Station)	Total Suspended Solids (mg/L)	Flow (cfs)	Flow Weighted Total Suspended Solids Load
275 - Cottonwood Rv near Plymouth (07182250)	182	881	2,589,550 lb/day
581 - Neosho Rv near Americus (07179730)	90	459	750,929 lb/day

The reservoir was constructed in 1959 and became operational in 1964. In 1963, John Redmond Lake had a conservation storage capacity of 82,231 acre-feet. The subsequent surveys have been taken of the lake bathymetry, the most recent in 1993, indicating a conservation storage capacity of 57,842 acre-feet. The loss of 6,803 acre-feet of storage over the period 1983 - 1993 represents

an average annual loss of 680 acre-feet per year. Current plans are for a two foot pool rise to reclaim storage lost to sedimentation. Conservation storage at 1041 feet was 77,459 acre-feet, resulting from a sedimentation rate of 693 acre-feet/year. At that rate the remaining storage at the end of the design period (2014) would be 62,900 acre-feet. At least 65,000 acre-feet is necessary to fulfill water supply and flow augmentation objectives.

Interim Endpoints of Water Quality (Implied Load Capacity) at John Redmond Lake for 2014: In order to improve the quality of the water column, the endpoint for John Redmond Lake will be an increase in average transparency as measured by Secchi Disc Depth of 0.8 meter. The current turbidity impairments impede primary productivity and dampens the support of aquatic life within the lake. However, a concomitant reduction in phosphorus loading must accompany any reduction in sediment loads and accompanying siltation. Much of the phosphorus entering John Redmond Lake is attached to sediment. In reducing sediment loads, the associated phosphorus loads should also be reduced, reflected in reduced in-lake total phosphorus concentrations. Modeling with CNET predicts that reduction of phosphorus levels, as specified in the John Redmond Lake Eutrophication TMDL, should allow Secchi Disc depths to reach 0.8 meter. This increased clarity will boost biological productivity in the lake without causing the inception of excessive eutrophic conditions.

A target storage of 65,000 acre-feet is designated for the year 2014. Assuming the recent sedimentation rate of 693 acre-feet per year continued from 1993 to 2003, an average rate of 503 acre-feet per year is necessary to maintain 65,000 acre-feet of storage by 2014. Given an explicit Margin of Safety, applied to the Load Allocation, storage should exceed the target endpoint storage in 2014.

This TMDL endpoint meets water quality standards as measured and determined by Kansas Water Quality Assessment protocols. These assessment protocols are similar to those used to cite the stream segments in this watershed as impaired on the Kansas 1998 Section 303(d) list.

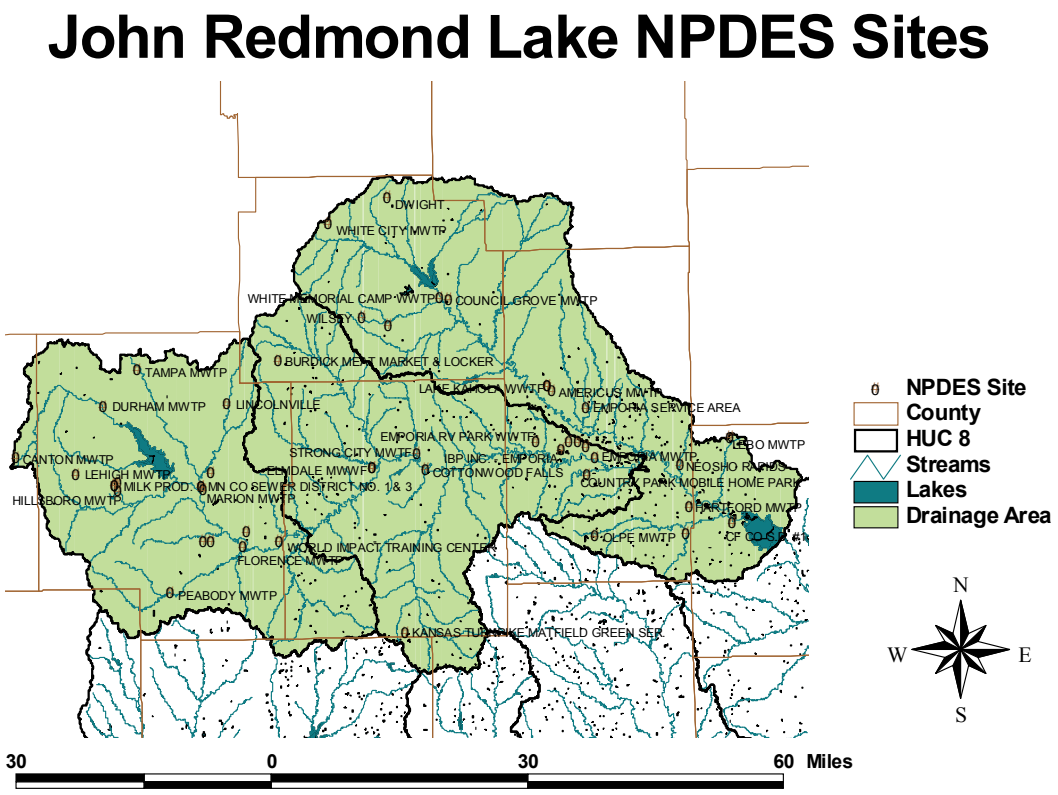
Seasonal variation in the endpoint is not established by this TMDL. This endpoint can be reached as a result of expected reductions in loading from the various sources in the watershed resulting from implementation of corrective actions and Best Management Practices, as directed by this TMDL. Achievement of the endpoints indicates loads are within the loading capacity of the stream, water quality standards are attained and full support of the designated uses of the stream has been restored, therefore the narrative water quality standard pertaining to suspended solids would be attained.

3. SOURCE INVENTORY AND ASSESSMENT

NPDES: Forty-eight NPDES permitted facilities are located within the watershed (Figure 3). Six are non-overflowing lagoons. Twenty-eight are unrelated to this TMDL (such as quarries and metal finishing facilities) or are outside the immediate watershed. The remaining fourteen have the potential to contribute to the nutrient load; they are listed below. Based on the effluent

limitations and the design flows, the discharging waste treatment plants would account for 3,228 pounds per day (589 tons per year) of total suspended solids.

Figure 3



Discharging NPDES Facilities in the immediate John Redmond Lake Watershed

Discharging NPDES Facilities	Type	Design Flow (MGD)	Expiration Date	TSS Limit	Load (lb/day)
EMPORIA MWTP	Trickling Filter, CMS Basin,UV	4.6000	12/31/03	30	1,152
IBP INC. - EMPORIA	Slaughtering operation	2.6000	12/31/03	30/80	1,332
COUNCIL GROVE MWTP	Three Cell Lagoon	0.4080	09/30/04	80	273
LEBO MWTP	Four Cell Lagoon	0.1400	12/31/03	80	94
AMERICUS MWTP	Three Cell Lagoon	0.1258	12/31/03	80	84
COTTONWOOD FALLS	Five Cell Lagoon	0.1200	01/01/03	80	80
STRONG CITY MWTF	Three Cell Lagoon	0.1050	12/31/03	80	70
HARTFORD MWTP	Three Cell Lagoon	0.0500	12/31/03	80	33
OLPE MWTP	Three Cell Lagoon	0.0500	12/31/03	80	33
NEOSHO RAPIDS WTF	Three Cell Lagoon	0.0450	12/31/03	80	30
WILSEY	Two Cell Lagoon	0.0228	01/01/03	80	15
KS TURNPIKE MATFIELD GREEN	Three Cell Lagoon*	0.0160	12/31/03	80	11
COUNTRY PARK MOBILE HOME COURT	Two Cell Lagoon	0.0112	08/31/03	80	7

COFFEY CO. S.D. #1 (JACOBS CREEK)	Three Cell Lagoon	0.0108	08/30/03	80	7
KS TURNPIKE - EMPORIA SERVICE AREA	Three Cell Lagoon*	0.0082	12/31/03	80	5
Total					3,228

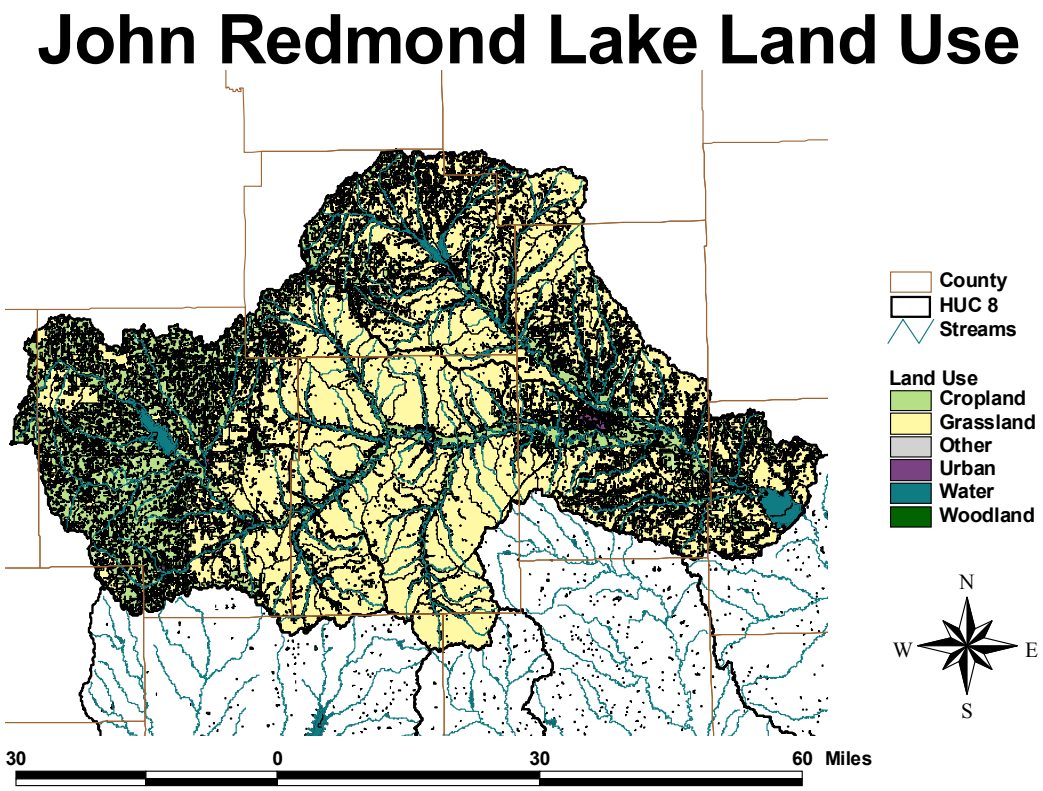
*Will soon build a non-discharging lagoon.

Below is a list of the non-overflowing NPDES facilities. Non-overflowing lagoons are prohibited from discharging and may contribute a total phosphorus or ammonia load under extreme precipitation events (flow durations exceeded up to 5 percent of the time). Such events would not occur at a frequency or for a duration sufficient to cause the impairments in John Redmond Lake.

Non-overflowing NPDES Facilities in the John Redmond Watershed

NPDES Facility Name	Type	Expiration Date
BURDICK MEAT MARKET & LOCKER	lagoon	6/30/04
ELMDALE MWWF	Three Cell Lagoon	5/31/04
EMPORIA RV PARK WWTF	Two Cell Lagoon	4/30/04
LAKE KAHOLA WWTF	One Cell lagoon	6/30/04
WHITE MEMORIAL CAMP WWTP	Two Cell Lagoon	1/1/04
WORLD IMPACT VOCATIONAL TRAINING CENTER	Two Cell Lagoon	8/31/04

Figure 4



Land Use: The siltation impairment is most likely due to cropland. Soil from exposed land runs-off into the lake, increasing the turbidity and concentration of total suspended solids and decreasing the transparency. Land use coverage analysis indicates that 30.2% of the watershed is cropland, and 64.8 % is grassland (Figure 4). More woodland and grassland are needed around the streams to prevent erosion.

Sediment from urban land may get transported into the watershed. However, this source is probably not a major contributor because there is minimal urban land (less than 1% of the watershed) around the lake and population projections for the county to the year 2020 indicate moderate growth (5.1%) in population. The population density of the Cottonwood subwatershed is 18.0 people per square mile. The density in the Neosho subwatershed is 20.4 people per square mile. The following population changes are expected:

Population Change (2000 to 2020)

Name	**% Change**
Alta Vista	8.3%
Americus	-4.0%
Burns	-5.8%
Bushong	-10.9%
Cedar Point	-19.2%
Cottonwood Falls	1.4%
Council Grove	10.7%
Dunlap	-19.7%
Durham	-11.4%
Dwight	2.1%
Elmdale	0.0%
Emporia	3.7%
Florence	10.2%
Hartford	-1.7%
Hillsboro	27.2%
Lebo	24.4%
Lehigh	5.1%
Lincolnville	-10.3%
Lost Springs	0.0%
Marion	-7.4%
Matfield Green	-20.0%
Neosho Rapids	3.3%
New Strawn	15.5%
Olpe	-0.7%
Parkerville	-16.0%
Peabody	-4.6%
Strong City	0.0%
Tampa	-12.9%
White City	8.4%
Wilsey	-8.8%

Contributing Runoff: The John Redmond subwatershed's average soil permeability is 0.4 inches/hour according to NRCS STATSGO database. About 98.5% of the watershed produces runoff even under relatively low (1.5''/hr) potential runoff conditions. Runoff is chiefly

generated as infiltration excess with rainfall intensities greater than soil permeabilities. As the watersheds' soil profiles become saturated, excess overland flow is produced. Generally, storms producing less than 0.5"/hr of rain will generate runoff from only 48.2% of this watershed, chiefly along the stream channels.

Background Levels: Carp may cause some resuspension of sediment. Background levels of total suspended solids come from geological sources. Sediment becomes suspended during high flow events as soil along the banks is eroded.

4. ALLOCATION OF POLLUTANT REDUCTION RESPONSIBILITY

The Load Capacity of John Redmond Lake is 503 acre-feet per year. Assuming a bulk determination of 60 pounds per cubic foot, the load capacity is about 657,320 tons per year (1,801 tons per day). More detailed assessment of sources and confirmation of the siltation impairment must be completed before detailed allocations can be made. The general inventory of sources within the drainage does provide some guidance as to areas of load reduction.

Point Sources: This impairment is partially associated with the Waste Treatment Plants. Ongoing inspections and monitoring of these NPDES sites will be made to ascertain the contributions that have been made by the source. These Waste Treatment Plants should comply with any future permit limits. Because of the Waste Treatment Plants contribute only 0.1% of the load capacity, no reduction in Total Suspended Solids Wasteload will be required at this time. Therefore, the Wasteload Allocation should be at 2 tons per day.

Nonpoint Sources: Siltation loading comes predominantly from nonpoint sources. Given the runoff characteristics of the watershed, overland runoff can easily carry sediment into the lake. The Load Allocation will be 1,619 tons per day.

Defined Margin of Safety: The margin of safety provides some hedge against the uncertainty of variable sedimentation and Secchi Disc Depth endpoint. Therefore, the margin of safety will be 180 tons per day of sediment taken from the load capacity subtracted to compensate for the lack of knowledge about the relationship between the allocated loadings and the resulting water quality.

State Water Plan Implementation Priority: Because John Redmond Lake has a large watershed which would consume most resources to implement, this TMDL will be a Medium Priority for implementation.

Unified Watershed Assessment Priority Ranking: This watershed lies within the Neosho Headwaters (HUC 8: 11070201) with a priority ranking of 38 (Medium Priority for restoration).

Priority HUC 11s: The Lower Cottonwood River subwatershed (HUC 11: 11070203010, 11070203020, 11070203030, and 11070203040) should take priority. Secondary focus should be placed the Neosho River subwatershed below Council Grove.

5. IMPLEMENTATION

Desired Implementation Activities

There is a very good potential that agricultural best management practices will improve the water quality in John Redmond Lake. Some of the recommended agricultural practices are as follows:

1. Maintain conservation tillage and contour farming to minimize cropland erosion.
2. Install grass buffer strips along streams.
3. Reduce activities within riparian areas.

Implementation Programs Guidance

Nonpoint Source Pollution Technical Assistance - KDHE

a. Support Section 319 demonstration projects for reduction of sediment runoff from agricultural activities as well as nutrient management.
b. Provide technical assistance on practices geared to establishment of vegetative buffer strips.

Water Resource Cost Share and Nonpoint Source Pollution Control Program - SCC

a. Apply conservation farming practices, including terraces and waterways, sediment control basins, and constructed wetlands.
b. Provide sediment control practices to minimize erosion and sediment and nutrient transport.

Riparian Protection Program - SCC

a. Establish or reestablish natural riparian systems, including vegetative filter strips and streambank vegetation.
b. Develop riparian restoration projects.

Buffer Initiative Program - SCC

a. Install grass buffer strips near streams.
b. Leverage Conservation Reserve Enhancement Program to hold riparian land out of production.

Extension Outreach and Technical Assistance - Kansas State University

a. Educate agricultural producers on sediment, nutrient, and pasture management.
b. Provide technical assistance on buffer strip design and minimizing cropland runoff.

Time Frame for Implementation: Priority consideration for installing pollution reduction practices within the stream drainage should be made after the year 2007. Evaluation of local water quality improvements in the watershed should occur prior to 2007 along with evaluation and upgrade of any inadequate point source contributors.

Targeted Participants: Primary participants for implementation will be agricultural producers

within the drainage of the lake. Initial work in 2007 should include local assessments by conservation district personnel and county extension agents to locate within the lake drainage:

1. Total row crop acreage
2. Cultivation alongside lake

Milestone for 2007: The year 2007 marks the midpoint of the ten-year implementation window for the watershed. At that point in time, sampled data from John Redmond Lake should indicate probable sources of sediment and plans in place to initiate implementation. Secchi Disc Depth should be greater than 0.5 meters and storage should be greater than 68,000 acre-feet below 1,041 feet.

Delivery Agents: The primary delivery agents for program participation will be conservation districts for programs of the State Conservation Commission and the Natural Resources Conservation Service. Producer outreach and awareness will be delivered by Kansas State Extension.

Reasonable Assurances:

Authorities: The following authorities may be used to direct activities in the watershed to reduce pollutants.

1. K.S.A. 65-171d empowers the Secretary of KDHE to prevent water pollution and to protect the beneficial uses of the waters of the state through required treatment of sewage and established water quality standards and to require permits by persons having a potential to discharge pollutants into the waters of the state.

2. K.S.A. 2-1915 empowers the State Conservation Commission to develop programs to assist the protection, conservation and management of soil and water resources in the state, including riparian areas.

3. K.S.A. 75-5657 empowers the State Conservation Commission to provide financial assistance for local project work plans developed to control nonpoint source pollution.

4. K.S.A. 82a-901, et seq. empowers the Kansas Water Office to develop a state water plan directing the protection and maintenance of surface water quality for the waters of the state.

5. K.S.A. 82a-951 creates the State Water Plan Fund to finance the implementation of the *Kansas Water Plan.*

6. The *Kansas Water Plan* and the Neosho Basin Plan provide the guidance to state agencies to coordinate programs intent on protecting water quality and to target those programs to geographic areas of the state for high priority in implementation.

Funding: The State Water Plan Fund annually generates $16-18 million and is the primary funding mechanism for implementing water quality protection and pollutant reduction activities in the state through the *Kansas Water Plan*. The state water planning process, overseen by the Kansas Water Office, coordinates and directs programs and funding toward watersheds and water resources of highest priority. Typically, the state allocates at least 50% of the fund to programs supporting water quality protection. This watershed and its TMDL are a Medium Priority consideration.

Effectiveness: Sediment control has been proven effective through conservation tillage, contour farming, and use of grass waterways and buffer strips. The key to success will be widespread utilization of conservation farming within the watersheds cited in this TMDL.

6. MONITORING

Additional data, to establish sediment loading, would be of value prior to 2007. Further sampling and evaluation should occur once before 2007 and once between 2007 and 2011.

7. FEEDBACK

Public Meetings: Public meetings to discuss TMDLs in the Neosho Basin were held January 9, 2002 in Burlington and March 4, 2002 in Council Grove. An active Internet Web site was established at http://www.kdhe.state.ks.us/tmdl/ to convey information to the public on the general establishment of TMDLs and specific TMDLs for the Neosho Basin.

Public Hearing: Public Hearings on the TMDLs of the Neosho Basin were held in Burlington and Parsons on June 3, 2002.

Basin Advisory Committee: The Neosho Basin Advisory Committee met to discuss the TMDLs in the basin on October 2, 2001, January 9, March 4, and June 3, 2002.

Discussion with Interest Groups: Meetings to discuss TMDLs with interest groups include:
Kansas Farm Bureau: February 26 in Parsons and February 27 in Council Grove

Milestone Evaluation: In 2007, evaluation will be made as to the degree of implementation which has occurred within the watershed and current condition of John Redmond Lake. Subsequent decisions will be made regarding the implementation approach and follow up of additional implementation in the watershed.

Consideration for 303(d) Delisting: The lake will be evaluated for delisting under Section 303(d), based on the monitoring data over the period 2007-2011. Therefore, the decision for delisting will come about in the preparation of the 2012 303(d) list. Should modifications be made to the applicable water quality criteria during the ten-year implementation period, consideration for delisting, desired endpoints of this TMDL and implementation activities may

be adjusted accordingly.

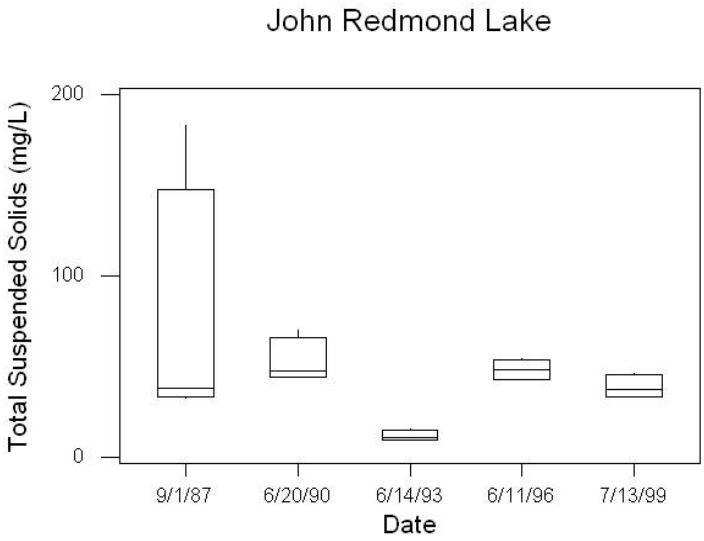
Incorporation into Continuing Planning Process, Water Quality Management Plan and the Kansas Water Planning Process: Under the current version of the Continuing Planning Process, the next anticipated revision will come in 2003 which will emphasize revision of the Water Quality Management Plan. At that time, incorporation of this TMDL will be made into both documents. Recommendations of this TMDL will be considered in *Kansas Water Plan* implementation decisions under the State Water Planning Process for Fiscal Years 2003-2007.

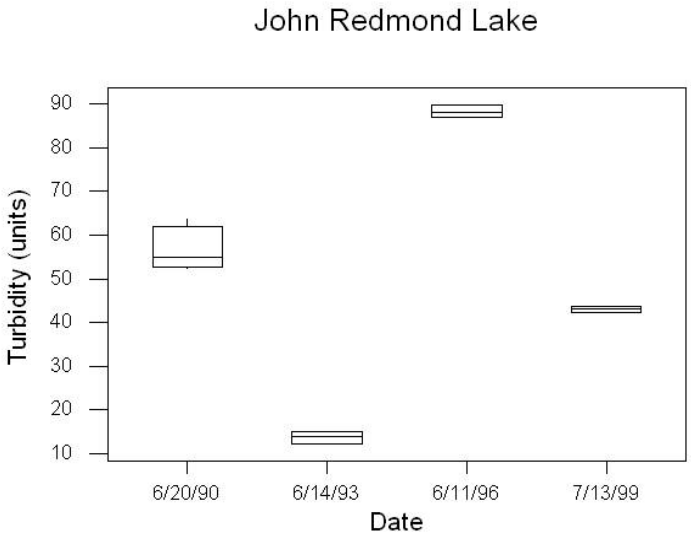
Bibliography

Lim, Niang Choo. "Assessment of Reservoir Water Quality and Its Application to Reservoir Management in the Central Plains." Thesis. University of Kansas. 2001.

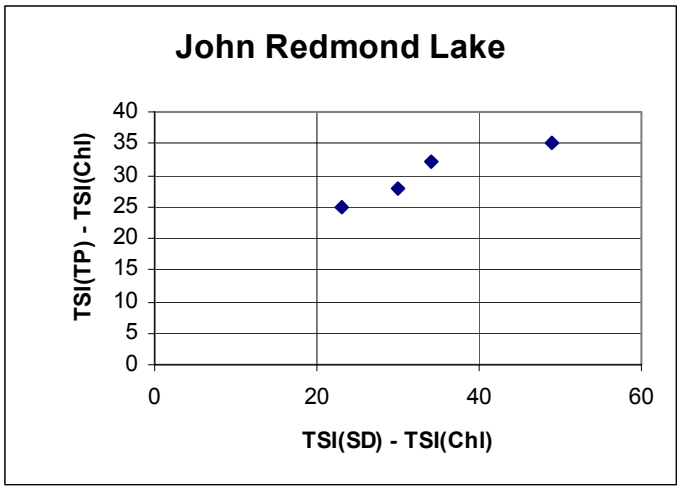
Liscek, Bonnie C. Methodology Used in Kansas Lake TMDLs [web page] Jul. 2001; http://www.kdhe.state.ks.us/tmdl/eutro.htm [Accessed 17 May 2002].

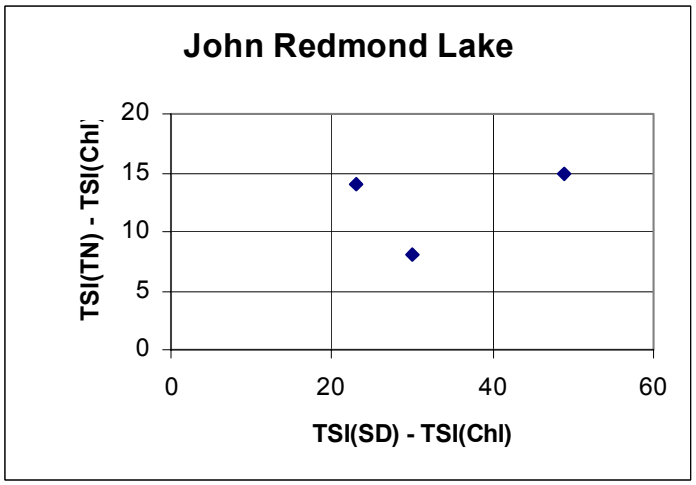
Appendix A - Boxplots





Appendix B - Trophic State Index Plots





The Trophic State Index plots indicate that light is the primary limiting factor, due to clay turbidity. This is inferred by examining the relationship between the TSI(SD) - TSI(Chl) and TSI(TP)-TSI(Chl) or TSI(TN)-TSI(Chl). The deviation of chlorophyll from the sediment load indicates the degree of light penetration, while the difference between chlorophyll and phosphorus, or chlorophyll and nitrogen indicates the level of phosphorus or nitrogen limitation. Therefore, if the final plot is in the first quadrant, it shows that the transparency of the water is impaired due to the presence of small particles, and that phosphorus and nitrogen do not limit algae growth. The positive slope of the graph also indicates a correlation between phosphorus and transparency which is found when phosphorus is bound to non algal particles.

Approved Feb. 27, 2003